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UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
In Cooperation with the University of Wisconsin

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Summary

This report establishes the suitability of Philippine hardwoods for the manufacture of tablet papers. Acceptable quality tablet paper was made from a furnish containing 60 percent Philippine hardwood kraft pulp and 20 percent each of Philippine hardwood thermomechanical pulp and commercial long-fibered pulp. Increasing the amount of thermomechanical pulp in the furnish resulted in a decrease in all properties except opacity.

Experimental

Wood Mixtures

Fifty species of Philippine hardwoods were used to make pulps for the tablet paper machine trials. The chips were made from bark-free wood in a commercial size, four-knife chipper. The nominal length of the chips was 5/8 inch, and the fines and oversize were removed prior

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[1] Maintained in Madison, Wis., in cooperation with the University of Wisconsin.

to blending of the individual species to obtain the mixtures. The mixture for the kraft pulp contained equal amounts (dry-weight basis) of 47 species listed in Table 1. As shown in Table 2, the mixture for the thermomechanical pulp contained equal amounts of the three lightest colored woods.

Kraft Pulping

Based on the results of preliminary kraft pulping studies made with mixtures of all 50 species combined in three different specific gravity distributions (AID Report No. 1), the following conditions were chosen to make pilot-scale digestions:

(a) 16.0 percent active alkali.

(b) 25 percent sulfidity.

(c) 4-to-1 water-to-wood ratio.

(d) 90 minutes to raise the temperature to 170° C.

(e) 90 minutes at 170° C.

Chips with a dry weight of 140 pounds were used in each pilot-scale digestion. At the end of cooking, the digester was blown. The resulting pulp was washed, screened through a 0.012-inch slotted flat screen, and wet lapped. The composite pulps had a Kappa number of 22.8.

Thermomechanical Pulping

The mixture of light-colored chips was converted into thermo-mechanical pulp at the pilot plant of C. E. Bauer, Springfield, Ohio. The chip mixture was given an initial 2-minute steaming at 30 p.s.i.g. and then fiberized to about 400 Canadian Standard freeness in a

418-pressurized refiner. This high-freeness pulp was returned to the Forest Products Laboratory (FPL) in order for us to have better control and more flexibility in subsequent refining stages to develop optimum properties of this pulp for use in various papers.

Preliminary atmospheric refining trials made with this high-freeness pulp in a 36-inch disk mill indicated that it was necessary to lower the freeness to about 125 Canadian Standard freeness in order to develop optimum properties. Consequently, the larger batches of pulp for the paper machine trials were refined to this freeness.

Bleaching

The Philippine hardwood kraft pulp was bleached to a brightness of 86.7 percent in a five-stage bleach consisting of chlorination, extraction, chlorine dioxide, extraction, and chlorine dioxide. The conditions are given in Table 3.

The thermomechanical pulp made from the three-species mixtures was too low in brightness for use in tablet papers, and it was therefore bleached to a brightness of 72.0 percent using a one-stage bleach of hydrogen peroxide. Bleaching conditions are given in Table 4. During the pressurized thermomechanical fiberizing stage, stresses are developed in the fibers. A recommended procedure for relieving these stresses is heating of the pulp slurry above 70° C. and agitating until a constant freeness value is reached. This so-called "latency" was effectively removed from the thermomechanical pulp under the conditions used to make the bleach.

Papermaking

Tablet paper weighing 16 pounds per ream, 17 by 22, 500 sheets ($60\ g/m^2$), was produced on an experimental Fourdrinier paper machine from furnishes containing various ratios of the thermomechanical pulp, Philippine hardwood kraft pulp, and a commercial U.S. western softwood bleached kraft pulp. The hardwood kraft pulp was refined in a pump-through disk refiner to a Canadian Standard freeness of 450 milliliters, and the softwood kraft pulp was refined in the same equipment to 500 milliliters. The pulps were blended in the machine chest with 1 percent rosin size and 9 percent clay added. The pH of the furnish was adjusted to 4.5 with sulfuric acid and alum. This pH was also maintained in the headbox of the paper machine. The papers were surface sized at the horizontal size press using a 9 percent solution of a medium-viscosity, ethylated-cornstarch. In one run, 0.2 percent of a cationic cornstarch was added continuously at the stuff mixing box.

Results

Pulp Properties

The handsheet properties of both the unbleached and bleached Philippine hardwood kraft pulps are given in Table 5. As was found in previous work with other tropical hardwood mixtures, the quality of these pulps was better than that of kraft pulps made from North American hardwood mixtures. Bleaching of the Philippine hardwood kraft pulp with CEDED increased the tearing resistance about 10 percent while maintaining the bursting and tensile strengths. The strength properties of the

commercial U.S. western softwood bleached kraft pulp are given in Table 6, and those of the bleached thermomechanical pulp are given in Table 7.

Tablet Papers

Results for the various tablet papers are presented in Table 8. For comparison, properties of a commercial U.S. tablet have been included in the table. Samples of the papers are included in the report.

Acceptable tablet paper was made from a furnish consisting of 60 percent Philippine hardwood kraft pulp and 20 percent each of the Philippine hardwood thermomechanical pulp and a commercial long-fiber pulp. Except for tear and smoothness, the paper was comparable to a commercial tablet paper used for reference. The tear could perhaps be improved with less refining of the long-fiber pulp or with a slightly higher percentage in the furnish. All of the experimental tablet papers were not as smooth as the reference presumably due to the greater degree of recovery from compression generally noted with thermomechanical pulps. The addition of the cationic starch to the furnish did not affect the sheet properties.

Increasing the thermomechanical pulp in the furnish to 35 percent resulted in a reduction in strength properties. When 50 percent thermomechanical pulp was used, a noticeable improvement in opacity resulted, and this paper had strengths nearly comparable to the paper with 35 percent thermomechanical pulp.

Conclusion

It appears that acceptable tablet paper can be made with as much as 80 percent of the Philippine hardwoods. Part of the hardwood can be prepared by the thermomechanical pulping process, but this pulp will require bleaching even when using only the light-colored species.

Table 1.--Names and Specific Gravities of the Philippine Hardwood Mixture Used to Make Kraft Pulp

Common name	Botanical name	Specific gravity
Tangisang-bayauak	Ficus variegata	0.236
Binuang	Octomeles sumatrana	.242
Kapok	Ceiba pentandra	.244
Balilang-uak	Meliosma macrophylla	.260
Kaitana	Zanthoxylum rhetsa	.296
Ilang-ilang	Cananga odorata	.308
Anabiong	Trema orientalis	.319
Hamindang	Macaranga bicolor	.324
Balanti	Homalanthus populneus	.356
Mayapis	Shorea squamata	.366
Matang-arau	Melicope triphylla	.381
Malasantol	Sandoricum vidalii	.394
White lauan	Pentacme contorta	.401
Tulo	Alphitonia philippinensis	.422
Tangile	Shorea polysperma	.429
Pahutan	Mangifera altissima	.435
Apanit	Mastixia philippinensis	.447
Lago	Pygeum vulgare	.451
Antipolo	Artocarpus blancoi	.469
Bagtikan	Parashorea plicata	.478
Sakat	Terminalia nitens	.485
Red Lauan	Shorea negrosensis	.510
Itangan	Weinmannia luzoniensis	.526
Piling-liitan	Canarium luzonicum	.549
Palosapis	Anisoptera thurifera	.554
Lomarau	Swintonia foxworthyi	.559
Malabetis	Madhuca oblongifolia	.560
Dangkalan	Calophyllum obliquinervium	.568
Panau	Dipterocarpus gracilis	.576
Katmon	Dillenia philippinensis	.592
Batitinan	Lagerstroemia piriformis	.597
Katong-lakihan	Amoora macrophylla	.608
Narig	Vatica mangachapoi	.618
Miau	Dysoxylum euphlebium	.623
Apitong	Dipterocarpus grandiflorus	.623

Table 1.--Names and Specific Gravities of the Philippine Hardwood Mixture Used to Make Kraft Pulp--Con.

Common name	Botanical name	Specific gravity
Bok-bok	Xanthophyllum excelsum	0.639
Kamatog	Erythrophloeum densiflorum	.650
Dalingdingan	Hopea foxworthyi	.667
Katilma	Diospyros nitida	.679
Yakal	Shorea astylosa	.718
Kamagong	Diospyros philippinensis	.720
Katong-Matsin	Chisocheton pentandrus	.725
Manaring	Lithocarpus soleriana	.736
Ipil-ipil	Leucaena leucocephala	.737
Bolong-eta	Diospyros pilosanthera	.743
Makaasim	Syzygium nitidum	.778
Alupag-amo	Litchi philippinensis	.793

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Table 2.--Names and Specific Gravities of the Philippine Hardwood Mixture[1] Used to Make Thermomechanical Pulp

Common name	Botanical name	Specific gravity
Rarang	Erythrina subumbrans	0.264
Gubas	Endospermum peltatum	.316
Dita	Alstonia scholaris	.316

[1] Mixture contained equal amounts (dry-weight basis) of each species.

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Table 3.--Bleaching of Philippine Hardwood Kraft Pulp Used in Tablet Papers

Stage	Chlorination	Extraction	Dioxide	Extraction	Dioxide
Chemical:					
Formula	Cl_2	NaOH	ClO_2	NaOH	ClO_2
Amount applied...pct:	5.5	2.0	0.76	1.0	0.38
Temperature.....°C:	25	71	68	50	70
Consistence.....pct:	1.9	10.6	4.0	10.9	3.6
Duration.....min:	60	60	120	60	180
pH:					
Initial.....:	2.8	11.4	--	11.8	--
Final.....:	2.7	11.3	6.7	11.6	6.5
Brightness.....pct:	--	--	--	--	86.7

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Table 4.--Bleaching of Philippine Hardwood Thermomechanical Pulp Used in Tablet Papers

Chemical:		
Formula		H_2O_2
Amount applied	pct:	0.96
Amount consumed	pct:	0.87
Temperature	°C:	73
Consistence	pct:	9.6
Duration	min:	300
pH:		
Initial		10.3
Final		9.3
Brightness:		
Orginal	pct:	54.7
Final	pct:	72.0

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Table 5.--Handsheet Properties of Unbleached and Bleached Philippine Hardwood Kraft Pulps Used in Tablet Papers

Properties	Unbleached				Bleached			
Beating time.....min:	0	14	27	42	0	13	29	37
Freeness (CSF).....ml:	615	505	390	240	580	480	335	230
Burst factor.....:	32	54	70	82	28	46	65	72
Tear factor.....:	116	121	115	108	130	132	129	125
Breaking length.....km:	6.8	9.7	10.6	12.3	4.9	7.2	9.6	10.2
Apparent density....g/cm^3:	0.56	0.62	0.66	0.70	0.62	0.64	0.70	0.70
Brightness.....pct:	25.1	--	--	--	86.7	--	--	--

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Table 6.--Handsheet Properties of Commercial U.S. Western Softwood Bleached Kraft Pulp Used in Tablet Papers

Beating time.....min:	0 :	25 :	40 :	55
Freeness (CSF).....ml:	720 :	550 :	410 :	235
Burst factor.....:	20 :	75 :	90 :	94
Tear factor.....:	304 :	162 :	141 :	128
Breaking length.....km:	3.7 :	9.4 :	10.9 :	11.2
Apparent density.....g/cm^3:	0.56 :	0.65 :	0.69 :	0.72
Brightness.....pct:	87.1 :	-- :	-- :	--

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Table 7.--Handsheet properties of bleached Philippine Hardwood Thermomechanical Pulp Used in Tablet Papers

Freeness (CSF).....ml:	170
Burst factor.....:	9.8
Tear factor.....:	40.3
Breaking length.....km:	2.5
Apparent density.....g/cm^3:	0.44
Brightness.....pct:	71.4
Scattering coefficient.....:	630
Opacity.....pct:	88.0

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Table 8.--Properties of Tablet Papers

Machine run No.[1]	Pulp furnish[2]			Properties[3]														
	Philippine hardwood		Western softwood bleached kraft[6]	Weight		Thickness	Density	Bursting strength	Tearing resistance		Folding endurance		Tensile strength		Porosity (Gurley)	Opacity	Smoothness (Bekk)	Brightness (Elrepho)	Ash
	Bleached TMP[4]	Bleached kraft[5]		Square meter	17x22, 500				Machine direction	Cross direction	Machine direction	Cross direction	Machine direction	Cross direction					
	Pct	Pct	Pct	G	Lb	Mils	G/cm^3	Pts	G	G	Double folds	Double folds	P.i.w.	P.i.w.	S/100 cm^3	Pct	S	Pct	Pct
Commercial U.S.				59.0	16.0	3.2	0.73	23.9	50.0	51.8	128	30	24.3	9.1	13.4	83.6	42.4	81.8	6.0
7111	50	40	10	60.2	16.0	3.8	.63	17.9	34.0	36.2	20	9	21.0	9.2	23.8	85.8	18.0	75.8	8.1
7112	35	45	20	56.3	15.0	3.4	.66	18.3	35.8	42.6	39	16	21.3	9.0	15.4	82.5	21.0	76.7	7.1
7113	20	60	20	60.2	16.0	3.4	.71	21.8	41.6	50.8	93	25	24.8	10.6	12.2	82.6	21.3	78.0	6.4
7113A	20	60	20	60.2	16.0	3.4	.69	22.4	40.6	49.4	97	22	25.1	10.6	11.3	82.8	22.9	78.4	7.8

[1] Surface sized at horizontal size press with a 9 percent solution of ethylated cornstarch.

[2] Each furnish had 1 percent rosin size and 9 percent clay filler added, and pH adjusted to 4.5 with sulfuric acid and alum. Machine run 7113A also had 0.2 percent cationic starch added continuously at stuff mixing box.

[3] Tests conducted in accordance with TAPPI Standard Methods.

[4] Thermomechanical pulp not refined.

[5] Refined in a pump-through disk refiner to a 450-milliliter Canadian Standard freeness.

[6] Refined in a pump-through disk refiner to a 500-milliliter Canadian Standard freeness.

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